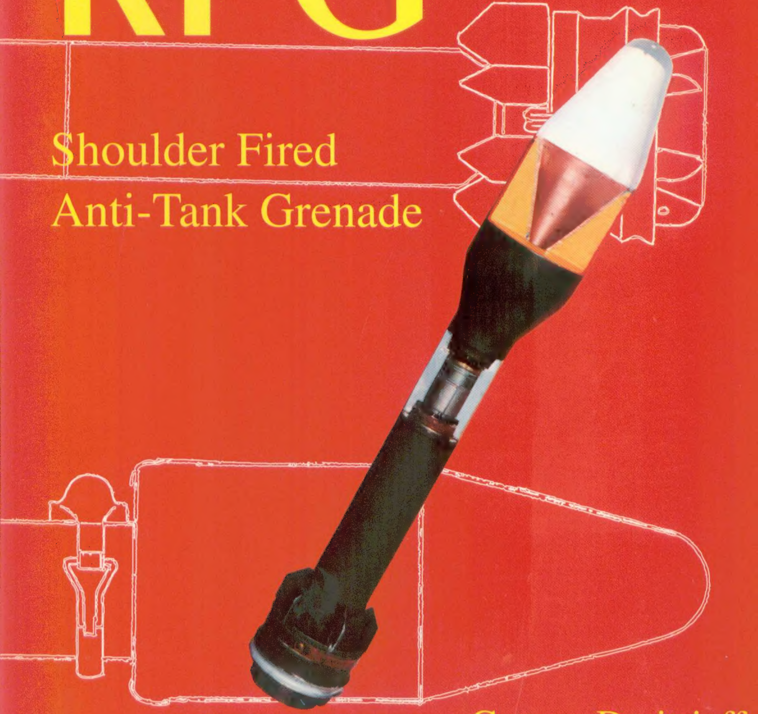
THE POOR MAN'S RPG

Shoulder Fired Anti-Tank Grenade



George Dmitrieff

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by

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Warning

The information provided in this monograph is not intended for the manufacture or use of the described antitank weapons.

Such weapons and devices are subject to various Federal, State, and local regulations. Furthermore, the construction of rockets and warheads entails handling of dangerous explosives and propellants which can cause serious injury or even death.

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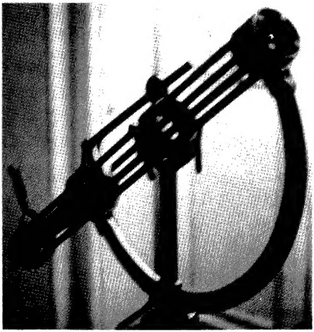
Chapter I
Historical Notes

Looking through the pages of military technology one common thread becomes apparent. It was the small, relatively simple inventions which had a profound effect on new tactics.

It was the simple stirrup which converted an armed rider on horseback into a formidable mounted war machine. The attachment of a spear point to the muzzle of a firearm changed the musketeer into an infantryman with impressive attack capabilities. The machine gun, in turn, forced the infantryman to use a shovel almost as much as the rifle, and practically eliminated the cavalry from the battlefield.



A "Bazooka" used by Austro-Hungarian Army in the 1860's

And lastly, the shoulder-fired rocket with a shaped-charge warhead made the tank (and the helicopter) quite vulnerable to fire by individual fighting men. If the rocket-launched antitank warhead, as recommended by military technologists in the 1930's, had been accepted by the various General Staffs, the concept of the Blitzkrieg would have been unthinkable.

While rockets were used since the twelfth century and the recoilless rifles were tested by the end of World War I, these weapon types were not equal in performance to the conventional artillery of the day. Furthermore, there was no need for antitank weapons when the tank did not exist.

The hand grenade has been called a one man's mortar. The shoulder fired HEAT (High Explosive Anti-Tank) warhead may be called a one man's artillery.

It is effective not only against armored vehicles, but has been used against bunkers, and as an antipersonnel projectile against troops in the open field.

In the Vietnam war the RPGs were even used against low-flying helicopters with success. This last application is not new in concept either. Towards the end of World War II the German Command was developing a "Fliegerfaust" intended to shoot down aircraft engaged in dive-bombing and strafing the ground troops. The famous "Stinger" is the most successful of this type application. Some information on these weapons is included in the appendix.

The first successful shoulder-fired HEAT warhead was the United States model M-9 rocket launcher firing the 2.36 inch (60 mm) M-6 series rocket. This weapon, introduced in 1942 in the North African theater of operations, was an immediate success. The weapon's basic elements of a fin-stabilized warhead with a shaped charge and standoff shield, propelled by recoilless means, have been copied and/or improved ever since. The Panzerfausts, RPGs, M-72A2 (LAW), Viper, Armbrust, Milan, etc., all incorporate some or most of the elements of the venerable Bazooka.

Now, let's review the principal requirements of a shoulder-fired antitank weapon. These are:

I - LETHALITY - i.e. the HEAT warhead has to stop and/or disable a tank even with a hit of the front glacis (the sloped front and most heavily armored part of the tank).

The World War II missiles were generally adequate for this purpose. It must be appreciated that any change in the warhead weight has 3-4 times that effect on the total projectile weight. An increase in warhead size will require a larger and/or heavier motor, more propellant and possibly a longer launcher just to keep the exterior ballistics the same as before. It is therefore most important to keep the warhead as small as possible and light, without loss of terminal effect. Such a light warhead in turn allows for reduction in the motor and propellant elements.

2 - HIT PROBABILITY - the ability to hit a target depends firstly on the projectile characteristics, such as in-flight velocity, (thus the time of flight from the launcher to the target) and the inherent accuracy (reduced dispersion due to better aerodynamic shape, propulsion method, fin design, etc.).

The second factor of hit probability is the type of sights used. An expendable, one-shot weapon usually uses the simplest kind of open sights. In turn a reloadable launcher is generally provided with good quality optical sights. Furthermore, such optical sights are normally sighted in with the launcher, producing a more accurate weapon. This was the principal advantage of the Bazooka over the Panzerfaust.

3 - RANGE- a longer range for a weapon is always desirable because it allows the shooter to engage the target earlier and also gives him a better survival chance against detection and retaliation fire.

The actual field use, however showed that the maximum effective range of the World War II weapons was only about 100 meters. Even today's improved models are considered practical to ranges of 250-300 meters. The tank size, moving target and the hit probability of the projectile are the limiting factors.

4 - PORTABILITY - the advantages of light weight and compact size are obvious. Unfortunately a compromise and trade-off are necessary in actual field product. The factors affecting the final decisions (aside from subjective opinions) are the tactical applications, anticipated major combat environment (deserts, woods, towns, etc.), resources available, and urgency of the end-user in getting the weapon. Again the Bazooka and the Panzerfaust are classic examples of the final decisions of such factor evaluation.

5 - COST - the cost of a system is representative of the labor and materials needed to produce a weapon without sacrificing on the above-mentioned performance parameters. This cost does not appear important when considering a few hundred or even thousand units. However, when such items are produced in hundreds of thousands and under emergency situations, the cost and the resulting drain on materials and production facilities can become critical.

The Bazooka and the Panzerfaust are classic examples of final decisions based on evaluation of the above factors.

While these weapons started with the Bazooka, a crew-served, non-expendable, bulky launcher, with long range and good accuracy, the other combatants made other decisions.

The British "PIAT" with the manual cocking of the launching spring was not only a sad concept, but did not compare with the systems described in this text. The Red Army in the beginning of the war did not have the time and resources for rocket propelled HEAT weapons. From 1943 they did not see the need for it. The Germans in turn did not see the need for individual antitank HEAT weapons till the 34's started rolling over their lines.

When the war was over and the various weapon evaluations started, the effectiveness of the Bazooka and Panzerfaust began to be fully appreciated. A new era of design and development began.

The key improvements of the later systems were:

- Piezoelectric fuze (i.e. instant acting)
- Better aerodynamic form of the projectile
- More powerful high explosive charge
- More reliable detonator
- Higher efficiency rocket motor

- Higher performance rocket propellant
- Addition of a primary launching cartridge
- Improved in-flight stabilization due to better fin design
- Use of optical sights
- Use of optional tracking guidance
- Use of reinforced plastic instead of metal, making components less expensive and lighter
- Improved production and assembly methods

At present the development of more powerful, lighter, more accurate, and longer range expendable shoulder-fired HEAT-warhead armed weapons continues in many countries. Such development is not the subject of this monograph.

In the present text the 3.5-inch HEAT, M28A2 rocket has been selected as a sample for the various re-enactment models. It is relatively simple in construction, reasonably reliable, and quite adequate for the purpose intended. The drawings and sketches of the individual components give sufficient information on the materials and methods of assembly of the rocket.

These methods were reflecting the knowledge and technology of the time. As manufacturing methods and experience grew, so did the design of new type rockets. The M72 rocket is therefore included for comparison. The most obvious changes are the new rocket motor made from aluminum alloy instead of steel and the tail assembly of thin blade individual fins. The ignition system has been changed from electric to percussion primer, like the old Panzerfaust, or the RPG. This allows for better storage life, simpler manufacture and a more reliable ignition.

And finally, the performance parameters, such as muzzle velocity, range and penetration have also changed. These parameters change quite often and are more influenced by the purchaser's subjective opinions than rationale. This is nothing new. It is similar to the continuous discussion of .45 caliber versus 9MM, the 5.56MM vs 7.62MM, the high cyclic rate multi-barrel 20MM vs 30MM or 57MM, the 100MM rifled tank gun vs the 120MM smooth bore, etc., etc. ad absurdum.

Section II

Propulsion Basics

The principle of rocket propulsion is based on the law of physics "every action produces an equal and opposite reaction." This, in simple terms is demonstrated in an example of a man sitting on a raft in the middle of a quiet pond. By jumping from the raft into the water the man pushes the raft in an opposite direction. The speed of the raft multiplied by the raft mass will equal the speed of the man multiplied by his mass. Similarly, the rocket warhead, or the recoilless rifle shell are the raft, while the gases (and other materials) "jumping away" "kick" the rocket-projectile towards the target. The projectile "pushing" system may be of three basic types.

A - a pure rocket in which the acceleration of the projectile is performed only by the reaction of the propellant combustion gases. Such performance is enhanced by a suitable combustion chamber and nozzle configuration. Some data on simple rocket propellants and rocket geometry are given in the Appendix. The Bazooka uses a pure rocket propelling system.

B - a pure "momentum" system in which the projectile mass (or weight) is accurately balanced by the mass (weight) of the gases and the metallic or plastic particles. Both are expelled from the tube with the same force and velocity so that the shooter does not feel any appreciable recoil of the launcher. The Panzerfaust was built on this principle.

C - a combination of the "momentum" and rocket. The two stage propulsion method, which launches the projectile like the Panzerfaust type recoilless charge and then several meters out of the launcher lights up the rocket motor. This approach is more complex mechanically than the single stage propulsion system but has the following merits:

- Lower launcher signature, i.e. less muzzle blast and smaller mass expelled to the rear.

- Reduced launch velocity.
- Shorter launcher.
- More adaptable for use in restricted space.
- The expelling unit acts essentially as the first stage of a rocket system improving the efficiency of the actual rocket motor.
- Allows for a more flexible design of the complete weapon system.
- Allows lighter motor construction since the rocket propellant may burn more slowly while accelerating the projectile down the range.
- Safety, in case of defects in construction and/or handling of the launcher, motor and the propellant charge, the shooter is not subject to the same high pressures and forces as in the single stage system. This is particularly important when considering the closeness of the shooter's head to the launcher during firing.

The penalty in using the two stage system is the inherently poorer accuracy, particularly in cross wind. While a one stage launched warhead is subject to the drift only, the projectile-with rocket motor which continues to burn during flight tends to turn head-on into the wind. The RPG7 is based on such a hybrid system.

So far everything is simple and straightforward. The real problem is in the practical configuration of such a launching method. The weapon must be as short and light as possible. Yet it must be powerful enough to penetrate and disable any existing (WW II) armored vehicle. It also has to have a reasonable range, flat trajectory and good accuracy to hit the target (approximately 3m wide by 2m high) moving at about 7 meters per second.

To hit and penetrate such armored targets requires a powerful projectile. In the past such a projectile was a high velocity kinetic penetrator. This was a hardened steel or tungsten sub-caliber projectile fired from an artillery weapon (gun or howitzer) of large caliber (75 - 150 mm). Obviously, a shoulder-fired launcher required a different type of projectile. The solution was a shaped charge warhead.

The basic characteristics of such warheads are discussed in detail in the next chapter. Although the launcher was reasonably short and light, the warhead had to be accelerated to its maximum velocity within the launcher length. This in turn required a development of a special propellant which would burn at relatively low pressure and produce a maximum gas volume within the time before the warhead exited from the front end of the launcher. Details of the material and design features of the propulsion components are described further in the text.

An interesting characteristic feature of the antitank shoulder launcher is the absence of recoil.

The propellant gases leaving through the launcher end nozzle (in the RPG-7 types) produce a reactive force forward, thus balancing the recoil forces. The force of gases on the front portion of the launcher chamber produce a barely noticeable launcher motion forward.

The performance specifications selected by the using service determine not only the final choice of the warhead and propulsion components, but also the type and form of the launcher. The U. S. Service apparently opted for longer range and a reusable weapon resulting in a 150 cm long Bazooka tube. The German Command selected a shorter range expendable unit, while the Soviet designers (after WW II) having the opportunity to study both systems, chose to use the best features of both.

To appreciate the performance of the World War II shoulder-fired rocket launchers consider that the HEAT warhead velocity, through its effective range, was about the same as the velocity of a .22 rimfire bullet, i.e. about 300 rn/sec. The weight of the high explosive charge in the warhead was comparable to that of 3-5 offensive type hand grenades. No wonder these devices are so popular with the irregular forces around the world even today.

The shapes and construction of these three basic launchers are shown in the respective chapters.

The energetic materials employed in the shoulder-fired antitank weapons may be separated into two groups:

A - Propellants, i.e. materials needed to launch the projectile to the target.

B - High Explosives, used in the shaped charge warhead.

Each of the above groups requires ancillary pyrotechnic and/or explosive materials such as igniters, delays, boosters, fuses, etc.

The propellants are almost invariably high energy, double base (Nitrocellulose with Nitroglycerine) powders adjusted for uniform burning at relatively low pressure (±500 Atmospheres = 7500 psi). The burning rate is designed so that the propellant grain is fully consumed within the time needed for the projectile to exit from the launcher. The burning rate is controlled by the appropriate chemical composition of the powder and the actual geometry of the powder grains. The control of the burning rate is more critical than that of normal artillery powders because the infantryman is exposed to any unburned or late burning propellant while the gunner is not.

For playacting and reenactment demonstration only the following may be applicable.

The most common solid propellant rocket fuel used by amateur rocketeers are:

Zinc dust powder	2/3 (by weight)
Sulfur powder	1/3 (by weight)

The components are placed into a non-sparking (wooden) container and blended by rotation and/or shaking of such container until a powder of uniform color is produced. For small quantities of propellant the most convenient method is to place the components onto a sufficiently large sheet of paper or dense cloth. By alternate lifting and lowering of the sheet sides, the material is uniformly blended. The blended propellant is carefully ladled into the rocket body with a non-sparking spoon. After the addition of a small portion of the powdered propellant, the rocket body is vibrated by tapping with a wooden or rubber mallet, or an electric vibrator (hand held electric sander) To prevent an open spark, the vibrator is enclosed in a heavy plastic bag.

The propellant will produce chamber pressures of about 70 Atmospheres (1000 psi). Addition of a small amount of ethanol to the blended powder produces a paste-like mix which can be stuffed into the rocket motor. It should be cured at ambient temperature for 5 to 7 days. The resulting rocket grain is a hard smooth material which can be sawed or machined. The grain requires more burning surface than the end burning type and therefore is usually formed in tubular form. This propellant will produce respectable results in a reenactment weapon, but the charge must be small to finish burning before the warhead exits.

The second, most common amateur rocket propellant is a mixture of:

Potassium nitrate	60 % (by weight)
Sugar	40% (by weight)

These components are blended in the same manner as the Zinc–Sulfur mix. The blended material is then slowly and carefully heated in a double boiler with glycerine (instead of water) to a temperature of 175° - 200°C (350 - 400° F). The molten mass is carefully poured directly into the rocket motor. To prevent air bubbles and stress cracks at cooling, all pouring ladles, funnels, and the motor body must be preheated to the melting temperature of 175°C. The propellant must be poured into the body in one step only. Any interruption in the pouring process will affect the grain cooling and cause cracks, resulting in erratic burning and possible explosion. This method of propellant preparation is used only by experienced individuals with proper equipment and under carefully controlled conditions.

The third basic rocket propellant is the venerable black powder which is available from sporting gun stores. However, the powder used in the traditional muzzle loading arms is more powerful than that used in the rockets. To make a rocket powder from the hunting powder approximately 40 grams of fuel (charcoal or sugar) are added to every 100 grams of the hunting black powder. The charcoal may be made from barbecue brickettes broken down and screened for size.

A one pound size coffee can with a piece of wood and a kitchen sieve are all the basic tools you'll need. The same can with a plastic cover also serves as a "blending drum" for the components, i.e. black powder and charcoal/sugar. This propellant blend will practically duplicate the traditional pyrotechnic rocket composition of:

Potassium nitrate - oxidizer	55 % (by weight)
Sulfur - fuel enhancer	10 %
Charcoal - fuel	45 %

More powerful rocket black powder propellants use a higher percentage of oxidizer, while reduced power propellants use less oxidizer.

The rocket propellant powder (blended) is poured into the rocket motor body in small portions and compacted as described in the respective section.

Many other types of reenactment expedient rocket propellants have been tried in the past. Smokeless rifle powders were blended with acetone, paraffin and other materials. The resulting propellant grains were sometimes difficult to ignite, some produced erratic burning rates while others generated excessively high pressures. None was as convenient as the propellants described previously.

The final source of propellant (and rocket motor) are the various rockets available from the hobby stores. These are generally the safest to use and are the best choice if the whole rocket and warhead (dummy) are of cardboard construction.

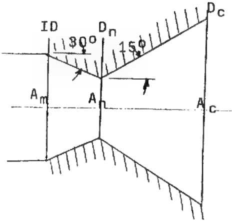
The rocket motor burning time and the appropriate length of the launcher can be determined by the following simple method.

Take a launcher with a tube about one meter longer than the estimated final length. Starting about three quarters of a meter from the rear end, drill in the launcher tube a series of holes (about 3/16 inch in diameter) approximately ten centimeters apart, toward the muzzle. Cover each hole with a piece of tape (ordinary Scotch tape or masking tape). When the rocket (with dummy warhead) is fired, the tape without burn marks shows the location where the propellant burned out.

In the reenactment rocket motor the igniter (see schematic diagram) is placed at the NOZZLE END of the motor. This is essential because the propellant in this case is only one solid grain of Zn-S composition.

To make motors (and hence the whole projectile) lighter, yet strong enough, the latest rocket motor bodies are manufactured from wound fiberglass filament. This very same method was used years ago to make the Winchester model 59 shotgun barrels. A paper-thin steel liner was reinforced by multiple windings of fiberglass filament. The barrel was then coated with epoxy and painted black.

REENACTMENT ROCKET NOZZLE DESIGN



FUEL: Zinc-Sulfur mix (2:1 by weight)
flame temperature ±1450°C
burning rate 230 cm/sec

Recommended relationships of nozzle

Area of Motor = 3 Area of Nozzle
Area of Cone $= 7^1/_2$ Area of Nozzle

TABULATED VALUES FOR REENACTMENT ROCKET MOTOR DIMENSIONS

MOTOR BODY NOMINAL SIZE PIPE Sch.40	MOTOR ID MM	ID^2	$^1/_3\ ID^2 = D_N^2$	D_N	$7^1/_2 D_N^2$	D_C
1"	24.4	642	214	14.6	1810	42.5
$1\ ^1/_2$"	41	1680	560	23.6	4200	64.7
M28A2	42			22		60

Note: the above reenactment motor values agree quite well with the actual Bazooka rocket motor dimensions, particularly when considering the differences in the fuels.

BURSTING PRESSURES FOR BUTTWELD STEEL PIPE

AS USED FOR THE REENACTMENT ROCKET MOTORS

PIPE NOMINAL SIZE inches	PIPE OUTSIDE DIA. millimeters	SCHEDULE 40 (STANDARD WEIGHT) PIPE INSIDE DIA. millimeters	BURSTING PRESSURE PSI
1"	33.2	26.7	9100
$1^1/_4$"	42.2	36.1	7600
$1^1/_2$"	48.2	41	6850

Note: For comparison, the 12-ga. shotgun barrel has an inside diameter of 18.5 mm and the maximum mean (not proof) pressure of a shotshell is 11,600 PSI (slug load).

The ignition systems of the propellant cartridges in the shoulder fired launchers are of two types:

a - mechanical

b - electrical

The mechanical ignition unit used in the Panzerfaust and the RPG may be compared to the conventional small arms unit. A pull on the trigger releases the hammer which hits the firing pin. The firing pin in turn strikes the small percussion primer, igniting the booster and the propellant itself. This system is simple, safe and reliable. Furthermore it may be inspected visually for defects.

The electrical ignition system consists of an electrical energy source, magneto , or battery, suitable wires and an electrical squib (a hot coil) imbedded in readily ignited booster. Pulling the trigger closes the circuit and sends an electric impulse through the wires to the squib. The thin wire of the squib is heated red, igniting the booster and the propellant. This system is also simple and reliable, but requires protection from external electromagnetic impulses by careful grounding. Inspection of the electrical circuit does require the use of an Ohm/Volt meter.

The Panzerfaust igniter is of the mechanical type. However, due to the type (recoilless) and the geometry of the launcher, such a mechanical igniter requires relatively large amounts of machining to make it positive and safe.

For reenactment purposes it is simpler and safer to use an electric igniter. Such an igniter may be attached to the propellant cartridge and seated into the launcher tube from the rear, prior to insertion of the expelling counterweight of sand and/or iron filings. This method assures that there are no openings in the launcher tube.

In summary, the advantages of a reenactment electrical igniter are:

- It does not require the equipment and tools needed to build a mechanical unit.
- The magneto assembly may be replaced by a battery.
- All components for the electrical circuit are readily available, off-the-shelf items (switches, wires, batteries , igniter/hot coil, booster powder).
- The construction of an electric unit is simple and the tooling needed consists of a pair of small pliers and a small soldering iron.

Reenactment Rocket Igniter, Electric

REENACTMENT ROCKET MOTOR ELECTRIC IGNITER

EQUIPMENT:

1 - Small hand drill with assorted drill bits

2 - Single edge razor blade

3 - Small file

4 - Small soldering iron

5 - Scissors

MATERIALS:

1 - Flashlight bulb (PR2 or equivalent)

2 - Black powder, FFFG

3 - Adhesive tape, Scotch tape type

4 - Adhesive cement for plastic models or equivalent

5 - Stopper, cork or rubber (to fit the motor nozzle diameter)

6 - Insulated wire; electronic equipment type

7 - Flashlight batteries, 2 each, D-cell

8 - Soft solder wire

PROCEDURE:

1 - Clean off approximately 4mm (3/16") insulation from two wires.

2 - Solder one wire (A) to the side of the flashlight bulb.

3 - Solder another wire (B) to the insulated knob at the bottom of the bulb.

Note: Be sure that the soldered ends of the wires do not contact each other, and are marked A-ground, B-hot.

4 - Drill a hole through the center line of the stopper large enough for both wires to pass through.

5 - Counter bore the small end of the tapered stopper so that the bulb body fits in snugly and seats to the rim.

6 - Pull the wires through the stopper hole.

7 - Apply a small bead of adhesive around the counter bore hole edge.

8 - Gently seat the bulb in place.

Note: Be sure that the soldered joints are not damaged.

9 - For safety apply adhesive at the exit end (large diameter of stopper) so that any accidental pull on the wires does not damage the soldered contacts.

10- After the adhesive dries, take the stopper with the bulb and with GENTLE and SLOW strokes file off the top of the glass bulb until a hole of approximately 3mm ($^1/_8$") diameter is formed.

11- Form a small funnel from a small paper strip; SLOWLY pour the black powder into the bulb so that it does not break the thin wire coil inside. Fill the bulb completely.

12 - While keeping the bulb in an upright position (to prevent spilling the black powder) close the bulb opening with a small piece of adhesive tape or a drop of glue.

13 - Connect the two wire ends to the battery; wire (A) to the "ground" or "-" end, the wire (B) "hot" is temporary shunted (connected) to the ground wire with a clip or other means.
The igniter is now ready for insertion into the rocket motor nozzle.

Notes:

1 - If a fine lead wire is not available, a piece of light duty electric extension cord (as used for small appliances) is usable.

2 - two (2) D-cell batteries (fresh) will actuate a PR2 bulb over 4 $^1/_2$ meters (15 feet) of light duty electric extension cord.

3- After step 8 check the electric conduction by two (2) D cell batteries; the bulb should light up if all joints are good. DO NOT test the connections after the bulb is filed open; it would burn the bulb filament and make the igniter inoperative.

The RPG2 is basically a copy of the Panzerfaust, hence the reenactment model may use the same electric igniter as the reenactment Panzerfaust. The RPG7 uses a mechanical igniter for the expelling charge and a delay which in turn ignites the rocket motor at a safe distance from the muzzle. Again, like in the reenactment Panzerfaust it is simpler and safer to use an electric igniter for the expelling charge and a delay igniter for the rocket motor.

Chapter III
Shaped Charge Warhead Basics

The shaped charge warhead of an antitank projectile is based on the technique of directional control of the energy generated during a high explosive detonation. Instead of allowing the gases to expand in a radial direction, they are focused into a narrow jet. This may be compared to a light being focused by a conical reflector into a sharp beam.

In a shaped charge warhead the fuze fires a primer which initiates the detonator which in turn sets off the main charge. The detonation wave of the formed charge reaches the apex of the liner producing very high pressure, causing the liner wall to collapse. The inner portion of the liner cone forms a molten jet travelling at a high speed along the charge axis. The velocity of this gas-metal jet approaches the burning rate of the high explosive used (i.e. 5000-8000 m/sec). Such a jet may penetrate armor to a depth twice that of the liner diameter. The jet-metal performance inside the target is further accentuated by the fragments of the armor from the penetration hole.

For the best performance the liner is brazed to the warhead body around its entire circumference. The joint is then carefully inspected and tested under hydrostatic pressure and very rigid controls. After the liner-warhead assembly passes the inspection, the standoff shield and the conductive hood (if the piezo fuze is in the projectile nose) is crimped and/or brazed to the warhead. After a final waterproofing with a silicone-like adhesive the warhead is ready for filling with the explosive charge.

The explosives used in the warhead are high energy materials. The final choice is dictated by the availability of such an explosive, the method of filling and forming the charge and the urgency to transfer the weapon into the end user's hands.

The 2.36 inch warhead (HEAT - M6) held approximately 450 grams of Pentolite, a mixture of PETN and TNT in 50/50 proportion. The 3.5 inch warhead (HEAT - M28A2) contained 850 grams of Composition B. The Panzerfaust 150 warhead was charged with approximately 900 grams of mixture of RDX and TNT in 50/50 proportion. Both, the PETN (Pentaerythritol tetranitrate) and RDX (Trimethylentrinitraamin) are excellent high explosives - powerful, relatively safe


2.36 INCH HEAT M6A5
ROCKET
WARHEAD


3.5 INCH HEAT M28A2
ROCKET
WARHEAD

in handling and storage, stable, and produced from readily available raw materials. Their one main drawback is in their physical form. They are fine powders and are not castable.

During filling and loading operations the PETN and RDX are usually blended with a small percentage of a binder, then compacted into small pellets to prevent dusting. Only then are these explosives deposited into the projectile (or mine) and compressed in a hydraulic press. Shaped charge warheads with thin and light walls are not readily suited for such compression of explosive filler. Thus PETN and RDX are added in loose powder form to molten TNT and blended into a thin porridge-like slurry. Such liquid is then poured into the warhead body and solidified by cooling.

This operation is a very closely controlled one. The metal parts of the warhead are first preheated to about five degrees Centigrade higher than the temperature of the poured explosive.

While the explosive is being poured, the warheads are vibrated to such a degree that a slight movement of the molten filler may be observed. The amount of the poured explosive exceeds slightly the required quantity for each charge. This, like in casting metals, eliminates the voids during shrinkage at cooling and assures a full and uniform warhead charge.

The overall performance of a shaped charge warhead depends on the following factors:

1 - Type of high explosive used in the main charge - the more powerful the better.

2 -Standoff distance - the distance between the base of the liner and the target surface. The target penetration increases with the increase of the standoff distance until the standoff equals about 3 times the liner diameter. Any further increase in standoff will decrease the penetration.

3 - Liner diameter - an armor penetration is about 1 $^1/_2$ times the liner diameter.

4 - Liner cavity form - a hollow cone of 42° produces optimum performance. Other forms tried were ellipsoidal, paraboloid, etc.

5 - Liner material: of all materials tried, the best was copper, then steel; aluminum was not very effective.

6 - Liner walls : tapering of the liner thickness improved the performance.

7 - Projectile rotation: high speed rotation (such as artillery shells) markedly decreases the shaped charge effect.

If the shaped charge and the target were stationary (like a cratering charge) the selection of the best condition would be relatively simple. However, the target and the projectile are mostly moving during the impact. The standoff distance then becomes a variable, depending on the impact angle of the warhead and the strength of the standoff shield. Furthermore, the projectile continues moving towards the target after the impact and before the detonator sets off the charge. In the early models of the Bazooka, Panzerfaust and the PG-2, the detonator was fired mechanically by impact of a striker against a percussion primer. This induced a long delay.

Present day warheads use mostly piezo-electric fuzes and electric bridge-wire detonators. This assures a practically instant detonator action.

Typical high explosive mixes used in the shaped charge warheads are:

		composition (by weight)
<u>Pentolite</u>	PETN	50%
	TNT	50%

This material has a density of: ±1.0 gram/ml (granular form)
±1.65 gram/ml (in cast form)

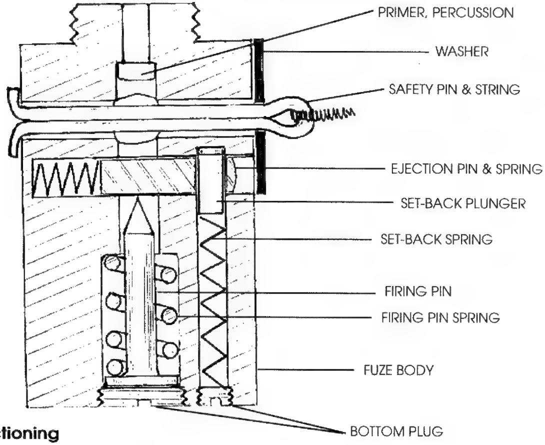
Detonation rate: 5500 m/sec (granulated)
7300 m/sec (cast)

<u>Composition B</u>	RDX	60 %
	TNT	40 %

<u>Octol</u>	HMX	75 %
	TNT	25 %

Pentolite, grade I, specification JAN-P-408 was used in the 2.36 inch M6A3 rocket. Although powerful, it is not as effective as the Composition B or Octol. Furthermore, in wet stage it is slightly corrosive to Copper, Zinc and brass. The composition B with a detonation velocity of 7800 rn/sec is used in a wide variety of explosive ammunition. It is powerful, stable, readily available and relatively easy to melt load. Octol, used in the M72 rockets has a detonation velocity of 8400 m/sec. Warheads with Octol filler have penetration and damage effect about 20% higher than the same warheads filled with composition B. Octol also allows a shorter standoff of shaped charges. However, at present the cost of Octol is about 3 times that of composition B. Both explosives are usually melt loaded at 90 ±3°C.

SCHEMATIC OF A MECHANICAL POINT-IMPACT NON-DELAY INERTIA FUZE FOR A HEAT WARHEAD



Functioning

1 - Safety pin is removed manually prior to loading of the projectile into the launcher.

2 - Upon firing the acceleration of the warhead forces the setback plunger back against the spring.

3 - This action releases the ejection pin; however, the pin cannot exit the fuze body because it is restrained by the launcher tube wall.

4 - Upon muzzle exit the ejection pin flies out of the fuze and the fuze becomes fully armed.

5 - Upon impact of the warhead against the target the inertia of the firing pin overcomes the spring force and the pin is driven into the primer, firing the detonator and the main charge.

Note: All elements are shown in a single plane to illustrate their relationship. In an actual fuze the components may be located along planes perpendicular to each other allowing for a compact and/or simpler assembly.

A simple mechanical fuze detonating on impact contains all, or most of the components described as follows:

1 - Safety wire or strip - locks all other safety elements and must be removed manually.

2 - Setback pin and spring - this spring-loaded pin prevents the ejection pin from moving. During firing of the weapon the projectile is subject to sudden acceleration. The inertia of the setback pin forces it back against its spring. This movement allows the ejection pin to move partially out of the fuze body.

3 - Ejection pin and spring - when the setback pin disengaged, the ejection spring forces the ejection pin partly out of the fuze. Since the projectile is still inside the launcher this pin cannot fly out. Only after the projectile exits the muzzle can the ejection pin leave the fuze completely. The ejector pin and spring are also called "bore safety" element.

4 - Striker and spring - only after the ejection pin is out is the passage free for the striker (firing pin) to move forward. However, the striker is held back by the striker spring. The impact of the projectile nose against the target causes a sudden deceleration (of the fuze elements) . The striker inertia overcomes the spring force and allows the striker to hit and fire the primer.

Reenactment Fuze "M1995",BD, Instant

Note: 1- This fuze is so sensitive that a drop head-on on a hard surface will fire it.

2- To ignite the warhead's main charge requires a booster; for reenactment a three (3) gram pellet of black powder will expel the simulated main charge (of flour).

3- The plastic components are attached with appropriate adhesive at assembly; drill hole for safety wire before inserting the firing pin (nail).

4- An 8 penny nail with the tip cut off flat is suitable to remove fired primers from the .410 ga shotshell 2 inch long case.

5- The bore safety nail is cut to fit the inside diameter of the launcher; it is secured by a strip of electrical tape, or equivalent. During loading, the tape is carefully removed while the safety is held by finger before insertion of the projectile into the launcher.

6- To assure positive and reliable primer ignition be sure that the firing pin (nail) strikes the center of the primer; use suitable washer and/or rubber sleeves for this purpose.

The warhead HEAT body is made from steel extrusion with walls about 2 millimeters thick. This requirement is dictated by the need to constrain and direct the filler explosion into a jet. If the body were made from a lighter and/or weaker material, such as sheet metal or plastic, the shaped charge would explode radially like a grenade. Although the reenactment warheads do not contain any high explosives, their overall weight is kept the same as the original HEAT component. This gives the reenactment item more reality in appearance and performance.

The reenactment warhead should be made from simple, readily available materials. The construction should not require extensive machining. The equipment should be restricted to such as is available in a typical household, i.e. electric hand drill, Skilsaw, a propane torch, and maybe a few plumbing taps and dies.

Following are a few work suggestions for how such a reenactment warhead may be constructed. For the body, use an empty soup can with the top removed and the edges rolled smooth. The bottom has a hole cut out to receive a standard male-female plumbing coupling screwed in and retained by a nut.

The liner is made as follows. A piece of wood of a diameter equal to the diameter of the can (body) is shaped at one end to the cone with a rounded point thus forming a mandrel. The wooden piece is held in the vise so that the pointed end is straight up. Now cut a piece of cardboard (from a file folder, for example) and form it into a cone on the mandrel. Seal the cut edge with tape (masking, plastic, etc.) on both sides if necessary to make a strong bond. The standoff shield is made in a similar manner, but using a stronger cardboard is necessary. The standoff shield may be built up of several layers glued together, until the desired rigidity is achieved. More on the standoff shield strength later.

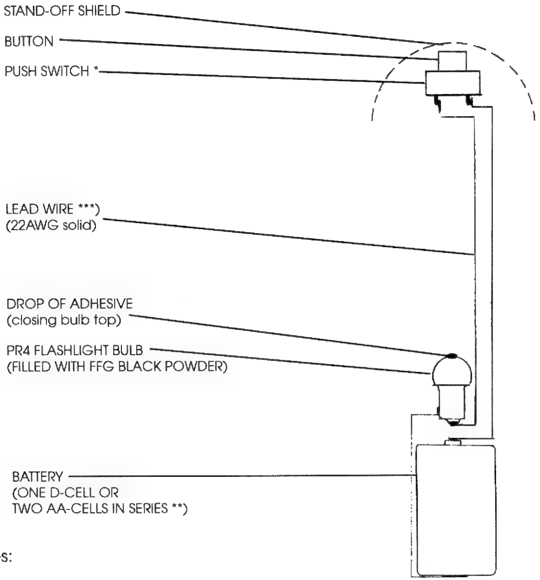
The reenactment warhead is assembled in the following manner: The liner is placed on the top (open end) of the body and secured with a tape and/or epoxy adhesive. Allow sufficient time for the adhesive to dry before checking the strength of the joint. If the liner is well secured, place the standoff shield over the body top and secure it with tape and epoxy adhesive.

If an electric nose fuze is to be used, the assembly order must be modified. The fuze is glued into the standoffs shield nose and the lead wires are carried through the warhead body, before the liner is placed in. A little slack in the wires is acceptable and will not affect the performance.

Now that the "metallic" parts are assembled, place the warhead upside down into a suitable holder which will keep the warhead without damaging the standoffs shield. A tall glass jar or a ring with a stand will be acceptable. Do not use a vise.

A good reenactment filler is talcum powder or flour with some bright red or orange pigment added. It will give a visible spot on the impact. A handmade paper funnel is inserted into the warhead body base. The filler is then spoon loaded into the body. Holding the warhead in one hand and gently tapping the body will assure a tightly packed filler. After the body is full to the bottom of

REENACTMENT WARHEAD ELECTRIC FUZE



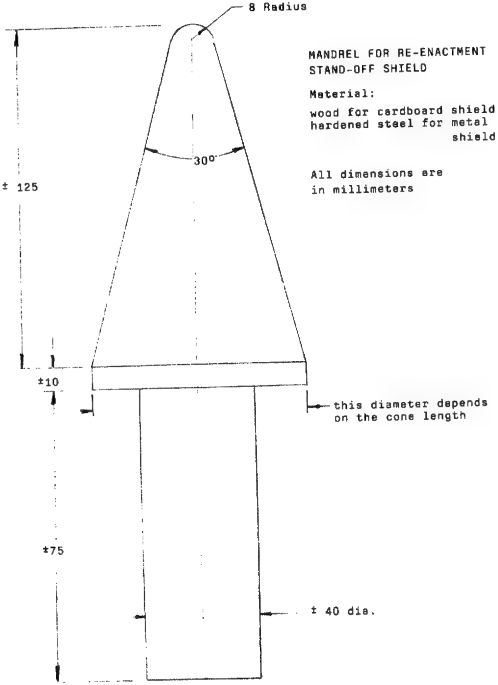
Notes:

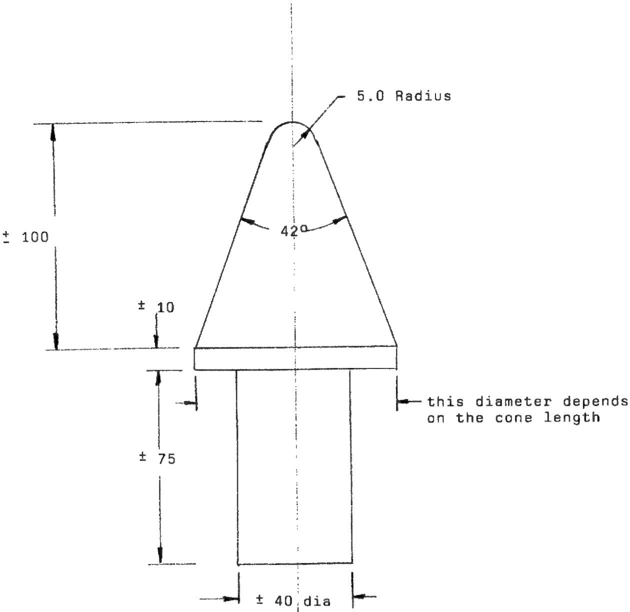
*) The switch must be tested with a dummy warhead to assure that the button does not compress the switch spring (and close the circuit) during warhead acceleration at firing of the rocket.

**) Two AA-cells weigh 46 grams vs. 135 grams of one D-cell; a suitable holder for the AA-cells is made from a strip of paper rolled on a 9/16 dia. wooden pin, and kept from unrolling by a piece of adhesive tape. Such a holder is light, yet sufficiently strong to keep the cells in place during projectile travel.

***) Solder all contacts for secure and positive connections.

the threads, remove the paper funnel and place a close fitting disc of wax paper over the filler. A small charge of black powder (3-4 grams) is then poured over the disc. Another close fitting wax paper disc is then seated over the powder. This disc is further secured by a small bead of adhesive (Elmer's glue, etc.) around its entire periphery. The reenactment warhead is now ready for assembly with the reenactment detonator and rocket motor units.

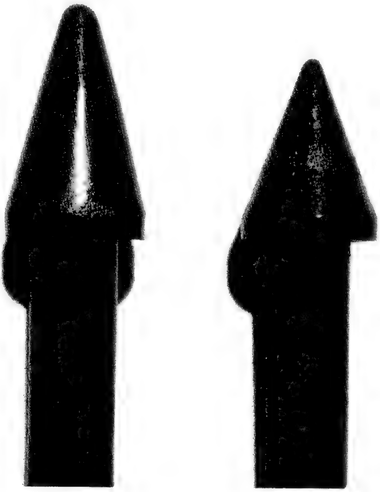




MANDREL FOR RE-ENACTMENT WARHEAD LINER

Material: wood for cardboard liner
hardened steel for copper liner

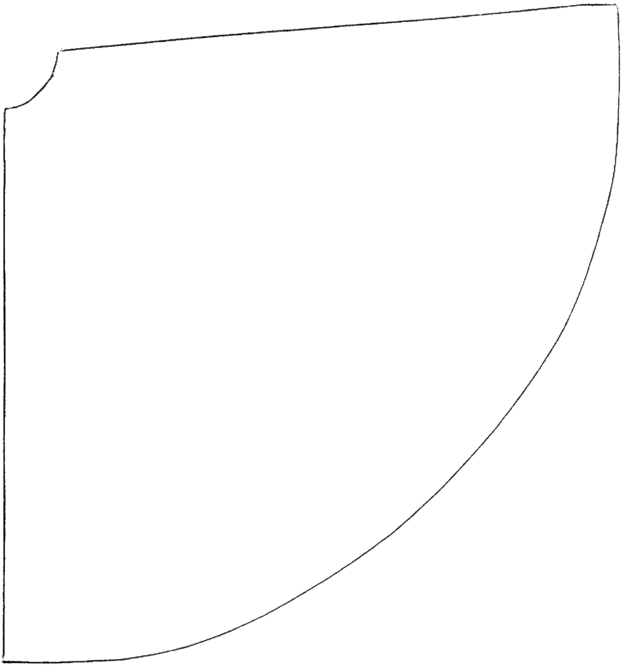
all dimensions are in millimeters



HEAT Warhead Mandrel

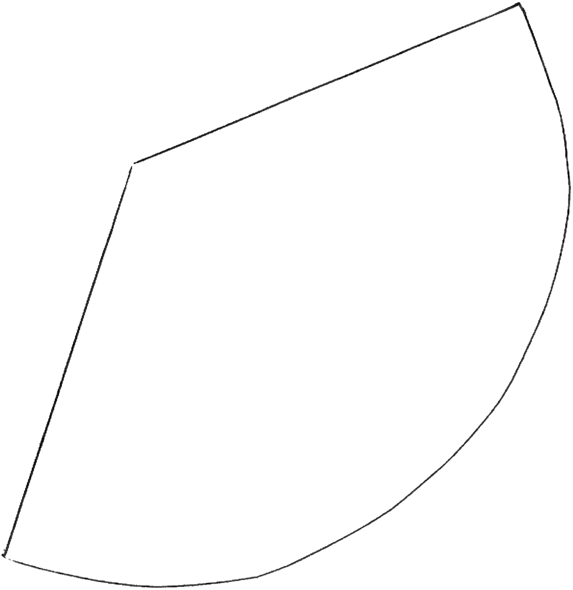
Left - Liner   Right - Shield

PATTERN FOR STAND-OFF SHIELD FOR A RE-ENACTMENT MILK CAN SIZE WARHEAD



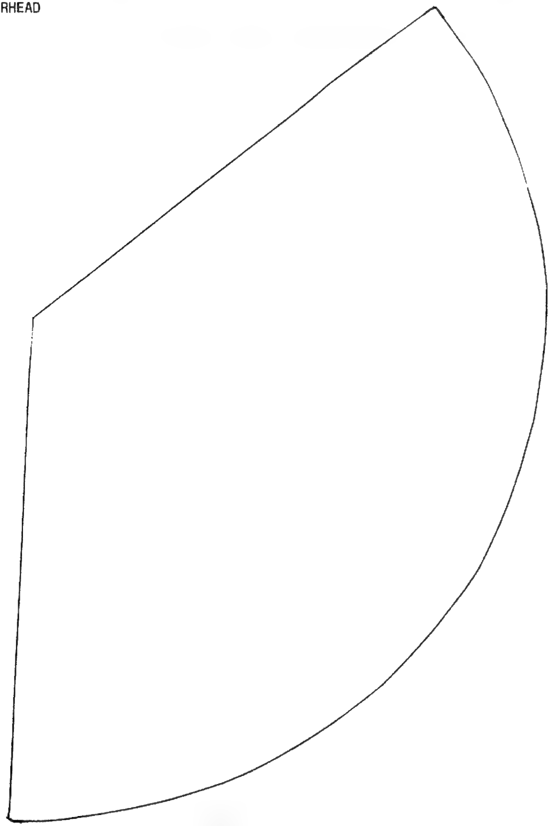
Pattern for stand-off shield for a reenactment milk can size warhead

PATTERN FOR LINER OF A RE-ENACTMENT MILK CAN SIZE WARHEAD



Pattern for liner of a reenactment milk can size warhead

PATTERN FOR A STAND-OFF SHIELD FOR A RE-ENACTMENT BEEF HASH CAN PANZERFAUST WARHEAD



Pattern for a stand-off shield for a reenactment Panzerfaust Warhead

Chapter IV
The Bazooka

The first successful individual weapon firing a shaped charge antitank warhead was the U. S. ARMY model M-9 2.36 inch rocket launcher commonly called Bazooka. The basic launcher, with minor modifications and the use of aluminum alloy components resulted in the Model M-18. During the Korean War the Bazooka underwent a major redesign which resulted in the 3.5 inch M-20 series. This weapon remained in service of the U. S. and NATO forces until the late 1950's. Its performance remains formidable even today.

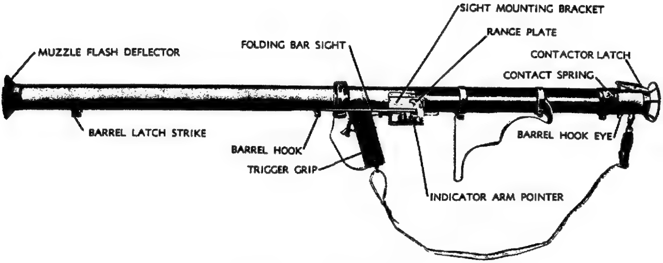
Some data of these models are given below.

Model	M-9	M-18	M-20
caliber of tube - mm	60	60	89
length of tube, folded - mm	800	800	760
ready to fire - mm	1550	1550	1330
weight of launcher- Kg	7.2	4.7	6.3
length of round- mm (HEAT)	495	495	600
length of warhead - mm			270
weight of round- Kg	1.57	1.57	4.1
weight of warhead- Kg	0.9	0.9	2.05
velocity, maximum-m/sec	82.5	82.5	102
range, maximum-m	550	550	830
range, effective-m	250	250	275
armor penetration at 0° - mm			280
firing mechanism	magneto	magneto	magneto
danger zone to rear of launcher - m			70

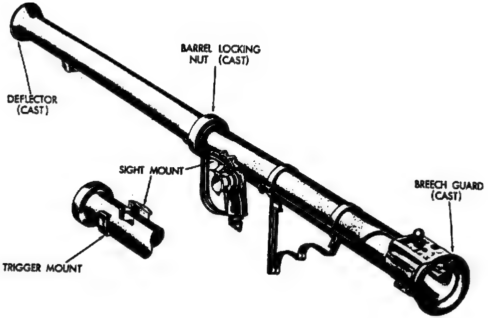
The propelling system of the Bazooka can be visualized as a small diameter rocket (motor) fastened to the rear end of the shaped charge warhead. The motor itself consists of a high grade heat treated steel tube filled with multiple propellant grains.

The rear end of the motor is closed by a diaphragm to create a combustion chamber. After the hot gases from the burning propellant reach the desired pressure level, the diaphragm ruptures and the gases pass through the nozzle to the rear. This action forces the rocket body in the opposite direction.

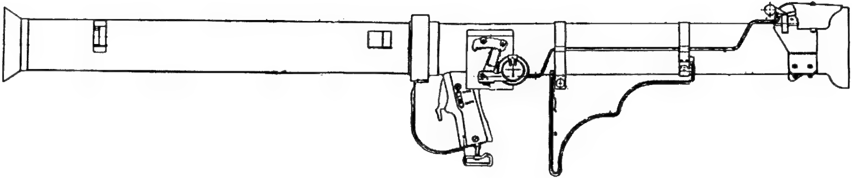
The Bazooka launcher is a steel tube (changed to aluminum in M-18) 61 inches long with an inside diameter of 2.37 inches. The ends of the tube are flared out to protect the tube body from dents which would prevent the entry and exit of the rocket. The launcher is equipped with a sight, pistol grip containing the firing mechanism and a skeleton shoulder support. The Bazooka is provided with a coupling device allowing the tube to be folded into two 31 inch sections. The model M-20 series launchers are enlarged and improved versions of the original M-9 model. The Bazooka is very effective, yet elegant by its simplicity. Following are some drawings showing the nomenclature and the details of the construction.



LAUNCHER,ROCKET, 2.36-INCH (60MM),M9



LAUNCHER,ROCKET,3.5-INCH(89MM),M20A1B1

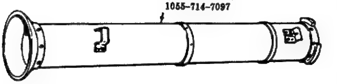


LAUNCHER, ROCKET, 3.5-INCH (89MM), M-20 SERIES

1055-575-0064 (M20)
1055-840-1841 (M20A1)
1055-840-1842 (M20A1B1)
1055-591-0217 (M20B1)

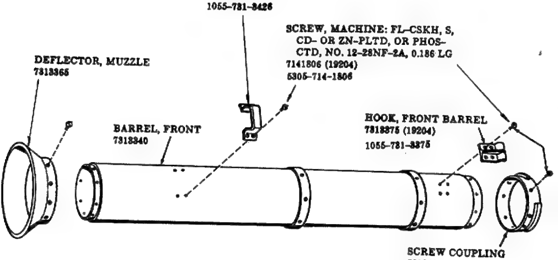
DIFFERENCES AMONG MODELS:

THE BARRELS OF THE M20 AND M20A1 ARE MANUFACTURED FROM ALUMINUM TUBE STOCK AND THE COMPONENT PARTS ARE FASTENED BY MEANS OF SCREWS. THE BARRELS OF THE M20A1B1 AND M20B1 ARE ALUMINUM CASTINGS AND MANY OF THE COMPONENT PARTS OF THE BARREL ARE CAST INTEGRAL WITH THE BARREL.

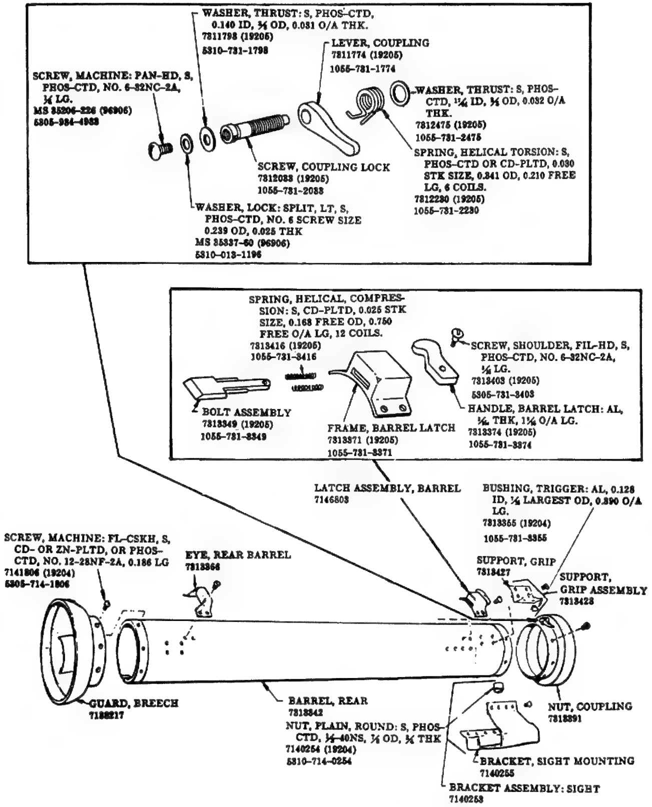


Front barrels and contactor latch assembly

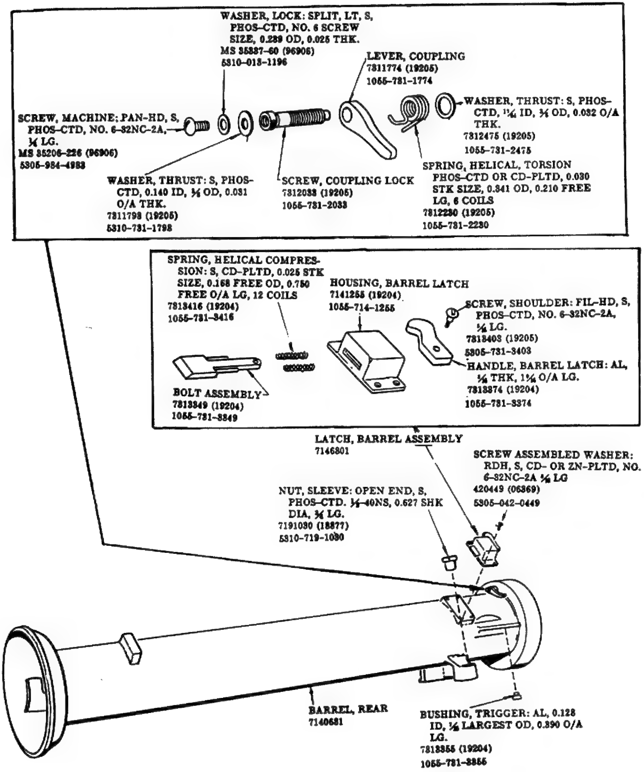
FRONT BARREL ASSEMBLY (M20A1 ONLY)



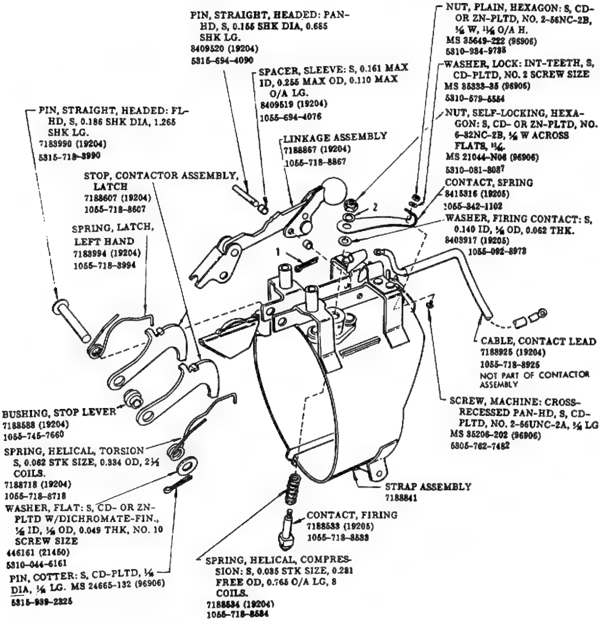
REAR BARREL ASSEMBLY
(M20A1 ONLY)



REAR BARREL ASSEMBLY
(M20A1B1 ONLY)



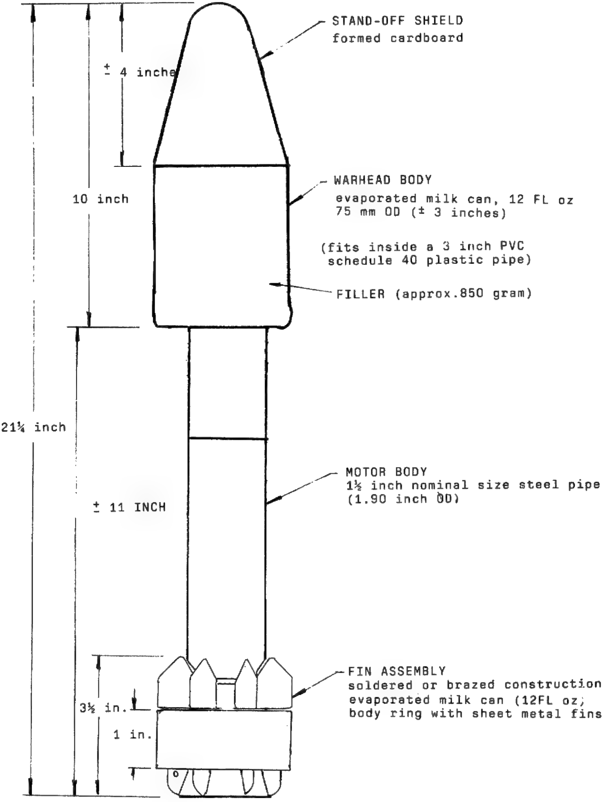
CONTACTOR LATCH ASSEMBLY
7162791 (M20A1 AND M20A1B1)

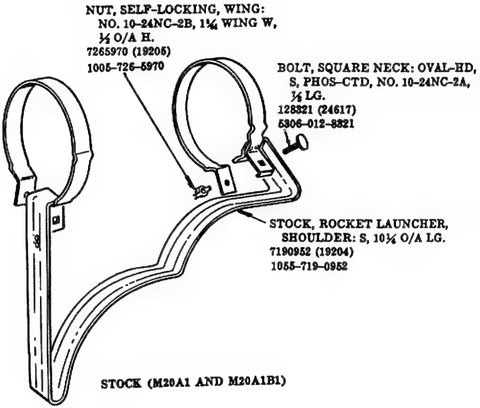


1 PIN, COTTER: S, CD-PLTD, ⅛ DIA, ⅛ LG.
MS 24665-132 (96906)
5315-939-2325

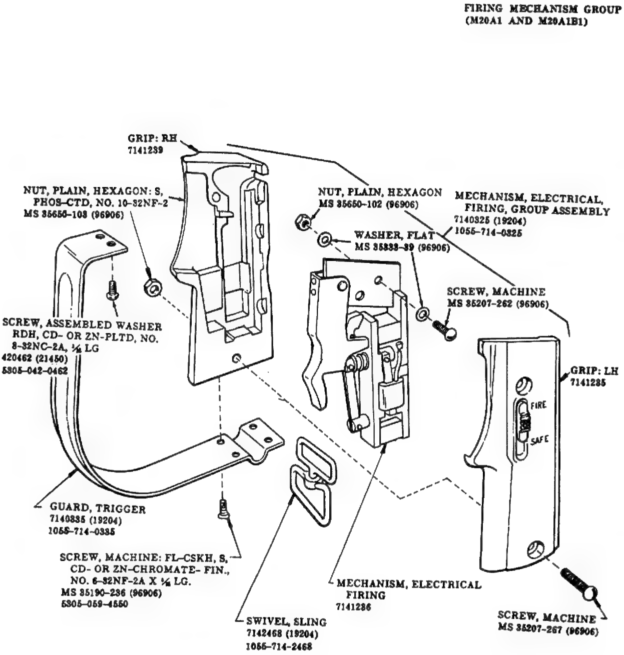
2 WASHER, LOCK: INT-TEETH, S, CD- OR ZN-PLTD W/CHROMATE-FIN., NO. 6 SCREW SIZE.
MS 35333-20 (96906)
5310-595-7235

RE-ENACTMENT 3.5 INCH ROCKET M28A2





STOCK (M20A1 AND M20A1B1)



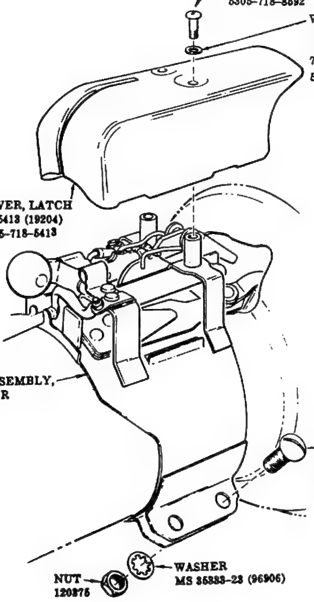
The Bazooka trigger mechanism conforms to the following requirements:

trigger pull , lbs. 7 - 14

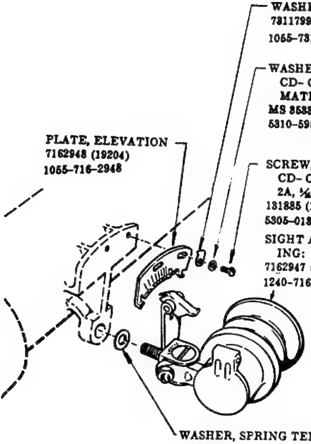
electric power generated - 48 milliwatt-seconds

electric firing system - 3 consecutive trigger pulls 30 seconds apart

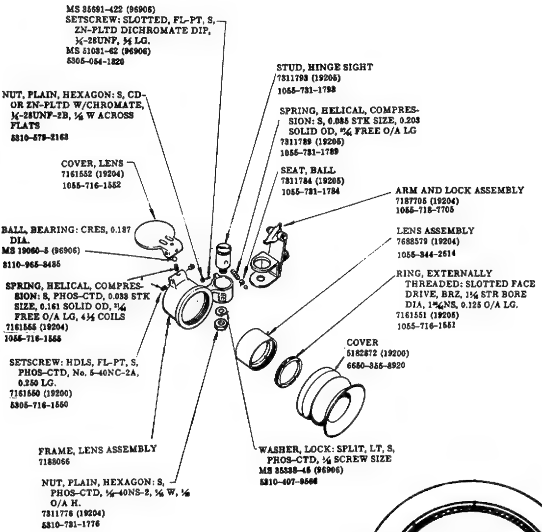
CONTACTOR LATCH ASSEMBLY
7184159 (M20A1 AND M20A1B1)

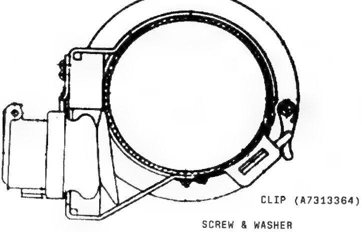


REFLECTING SIGHT GROUP (M20A1 AND M20A1B1)



REFLECTING SIGHT ASSEMBLY
7162947



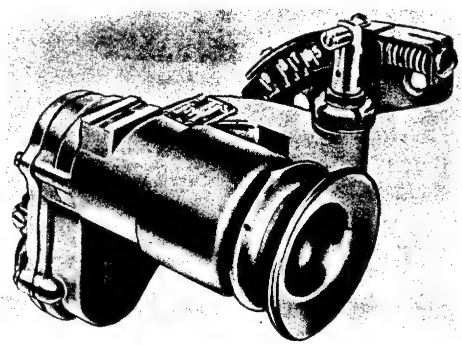


SIGHT ASSEMBLY
(Drwg.D7162947)

3.5 inch ROCKET LAUNCHER
(Drawing D7185425, section A-A)

SIGHT M39

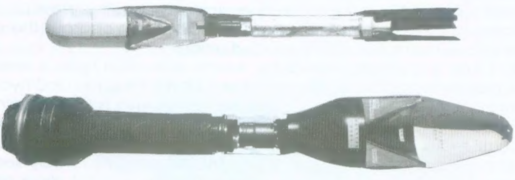
1240-346-8684



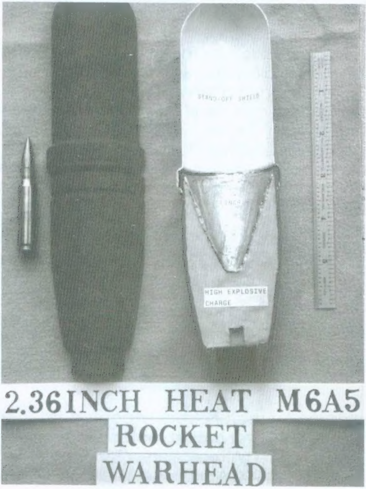
TITLE	NUMBER
LAUNCHER ROCKET 35 M2OAI	MIL-L-696
ALUMINUM-ALLOY (AL-I7 BARS, RODS, SHAPES & WIRE	OO-A-351
ALUMINUM ALLOY 24S;BARS, RODS, AND WIRE-ROLLED OR DRAWN	QQ-A-268
ALUMINUM ALLOY 24s; BARS, RODS AND SHAPES-EXTRUDED	QQ-A-267
ALUMINUM ALLOY (AL-24), PLATES, SHEETS & STRIPS	QQ-A-355
ALUMINUM ALLOY DIE-CASTINGS	QQ-A-591
ALUMINUM ALLOY; FORGINGS, HEAT-TREATED	QQ-A-367
ANODIC-FILMS; CORROSION PROTECTIVE, FOR AL ALLOYS	FXS-963
BRASS, COMMERCIAL, BARS, PLATES, RODS, SHAPES, SHEETS AND STRIPS	QQ-B-611
BRASS, LEADED AND NON-LEADED COPPER-ZINC ALLOY RODS, BARS, SHAPES, AND FORGINGS	QQ-B626
BRONZE, PHOSPHOR; BARS, PLATES, RODS, SHAPES, SHEETS, & STRIPS	AA-B-746
CABLE, (HOOK-UP WIRE), ELECTRIC, INSULATED	JAN-C-76
CLEANING, PRESERVING, PACKAGING, PACKING AND MARKING OF SMALL ARMS SPARE PARTS	SAPD-1000
COMPOUND CORROSION PREVENTIVE PETROLATUM-TYPE, HOT APPLICATION	MIL-C-11796
COPPER BARS, RODS AND SHAPES	QQ-C-502
COPPER SILICON ALLOY, CASTINGS	QQ-C-593
COATINGS, PHOSPHATE,PROTECTIVE (FOR IRON AND STEEL)	MIL-C-12968
ENAMEL, SYNTHETIC LUSTERLESS	TT-E-527
ENAMEL, SEMI-GLOSS, RUST-INHIBITING	TT-E-485
FILMS CHEMICAL CORROSION PREVENTIVE FOR AL & AL -ALLOYS	MIL-C-5541
FINISHES, PROTECTIVE FOR IRON AND STEEL PARTS	57-0-2
FLUX, SOLDERING PASTE	Q-F-506
GLASS FIBER; YARN, CORDAGE, SLEEVING, CLOTH AND TAPE	MIL-G-1140
GREASE, LUBRICATING, GRAPHITE	VV-G-671
INSULATION; ELECTRICAL, SYNTHETIC-RESIN COMP, NON RIGID	MIL-I-631
IRON, MAGNETIC, BAR, SHEET, AND STRIP	MIL-I-11695
LENS, REFLECTING SIGHT, ASSEMBLY	MIL-L10000
LUBRICATING-OIL,PRESERVATIVE, SPECIAL	JAN-L-644
MANUFACTURE AND INSPECTION OF SMALL ARMS WEAPONS AND ACCESSORIES	52-0-1
METALS, GENERAL SPECIFICATION FOR INSPECTION OF	QQ-M-151
PERMANENT MAGNET, SHAPES	QQ-M60
PHENOLIC (MOLDED SHAPES)	MIL-P-10420

63	PLASTIC-MATERIALS, LAMINATED THERMOSETTING RODS & TUBES	MIL-P-79
64	PLASTIC MATERIALS, LAMINATED THERMOSETTING SHEETS & PLATES	MIL-P-3115
65	PLASTICS, ORGANIC, GENERAL SPECIFICATIONS TEST METHODS	L-P-406
66	PLASTIC, POLYSTYRENE, MOLDED	L-P-461
67	PLASTIC, POLYETHYLENE, MOLDED AND EXTRUDED SHAPES,	
68	SHEETS AND TUBING	MIL-P-3803
69	PRIMER, ZINC, YELLOW	3-201
70	PLATING,CADMIUM (ELECTRO DEPOSITED	OO-P-416
71		
72		
73	RUBBER & SYNTHETIC RUBBER COMPOUNDS, GENERAL PURPOSE	
74	(EXCEPT TIRE, INNER TUBES SPONGE RUBBER AND HARD RUBBER)	MIL-R-3065
75		
76		
77		
78	SOLDER, SOFT (TIN, TIN-LEAD, AND LEAD-SILVER)	QQ-S-571
79	STEEL, ALLOY BARS (GENERAL PURPOSE)	QQ-S-624
80	STEEL, CARBON, BARS (GENERAL PURPOSE)	QQ-S-633
81	STEEL, CARBON, SHEET AND STRIP	QQ-S-640
82	STEEL, CORROSION-RESISTING, BARS, AND FORGINGS EXCEPT	
83	FOR REFORGING	QQ-S-763
84	STEEL, SPRING SPECIAL COLD ROLLED STRIP ANNEALED	SXS-160
85	STEEL, TOOL, ALLOY	QQ-S-778
86	STEEL, TOOL, CARBON VANADIUM	QQ-S-779
87	SURFACE ROUGHNESS WAVINESS AND LAY	MIL-STD-10
88		
89		
90		
91	TUBING, AL-ALLOY AL-24 AL-CU-MG-(1.5%) -MN, ROUND SEAMLESS	WW-T-785
92	TUBING, BRASS, LEADED, ROUND, SEAMLESS	57-191
93		
94		
95		
96	VARNISH MOISTURE-AND FUNGUS-RESISTANT FOR THE TREATMENT	
97	OF COMMUNI CATIONS, ELECTRONICS, AND ASSOCIATED	
98	ELECTRICAL EQUIPMENT	MIL-V-173
99		
100		
1'01		
102	WELDING, NOMENCLATURE AND DEFINITIONS	MIL-STD-20
103	WELDING OF CONSTRUCTIONAL STEEL, GAS, MANUAL OR MACHINE,	
104	FOR ARTILLERY AND SMALL ARMS MATERIAL EXCLUDING	
105	SUBMARINE MINES AND OBSERVATION TOWERS	52-206-11
106	WELDING OF CONSTRUCTION STEEL, RESISTANCE SPOT	57-206-21
107	WELDING SYMBOLS	JAN-STD-19
108	WIRE, MAGNET	JAN-W-583
109	WIRE, STEEL (CARBON), BARE & ZINC COATED	QQ-W-461
110	WIRE, STEEL CARBON, SPRING, MUSIC	QQ-W-470
111	WIRE, STEEL CORROSION-RESISTING	QQ-W423
112	WIRE, STEEL, SPRING, FOR SMALL ARMS WEAPONS	48-7-1

1	LIST OF DRAWINGS	D7185425 SHT 1
2	LIST OF SPECIFICATIONS	D7185425 SHT 2
3	SIDE VIEWS	D7185425 SHT 3
4		
5		
6	COMBINED LIST OF ALL PARTS & SPARE PARTS	D7145211
7	COMBINED LIST OF ALL PARTS & SPARE PARTS	D8237083
8	COMBINED LIST OF ALL PARTS, SPARE PARTS,	
9	EQUIPMENT AND TOOLS	D7189990
10		
11		
12		
13	DIAGRAM TARGETING	D7138250
14		
15		
16	ASSEMBLIES	
17	BARREL, FRONT ASSEMBLY	D7147097
18	SIGHT, REFLECTING, ASSEMBLY	D7162947
19	STOCK ASSEMBLY	D7190952
20	BARREL, REAR, ASSEMBLY	D7313343
21		
22	MECHANISM, ELECTRICAL FIRING, GROUP ASSEMBLY	C7140325
23	COIL ASSEMBLY, FIELD	C7141237
24	ARM AND YOKE ASSEMBLY	C7145540
25	LATCH CONTACTOR ASSEMBLY	C7162791
26	HANDLE CONTROL ASSEMBLY	C7185415
27	ARM AND LOCK ASSEMBLY	C7187705
28	LEVER ASSEMBLY	C7188566
29	LENS, REFLECTING SIGHT, ASSEMBLY	C7688579
30		
31		
32	BRACKET, SIGHT, ASSEMBLY	B77140253
33	GRIP, LEFT HAND, AND SAFETY ASSEMBLY	B7141235
34	MECHANISM, ELECTRICAL FIRING ASSEMBLY	B7141236
35	LATCH ASSEMBLY, BARREL	B7146803
36	LATCH, CONTACTOR, GROUP ASSEMBLY	B7184159
37	SPRING DETENT ASSEMBLY	B7185420
38	FRAME, LENS ASSEMBLY	B7188066
39	BRACKET, SLING, ASSEMBLY	B7188803
40	POST & FRAME ASSEMBLY	B7188830
41	STRAP ASSEMBLY (WELDMENT)	B7188841
42	LINKAGE ASSEMBLY	B7188867
43	CABLE, CONTACT LEAD ASSEMBLY	B7188925
44		
45		
46	PLATE, BACK AND BRACKET, ASSEMBLY	A7141227
47	TRIGGER AND SPRING ASSEMBLY	A7141228
48	LATCH ASSEMBLY	A7141229
49	RIGGER AND LATCH ASSEMBLY	A7141230
50	ARMATURE, SLEEVE AND SPRING ASSEMBLY	A7141231
51	LOOP AND BOSS ASSEMBLY	A7142467
52		
53	SWIVEL, SLING, ASSEMBLY	A7142468
54	SOCKET, ASSEMBLY	A7185421
55		
56	BOLT, BARREL LATCH, ASSEMBLY	A7313349
57	SUPPORT, GRIP, ASSEMBLY	A7313428
58	CONNECTOR ASSEMBLY	A8402353
59		
60	PACKING AND MARKING DRAWINGS	
61	LIST OF PACKAGED SPARE PARTS	



Top: 2.36 inch HEAT M6A5 rocket Bottom: 3.5 inch HEAT M28A2 rocket



2.36 inch HEAT M6A5 rocket warhead

The M6 series projectile consists of the HEAT warhead, fuze, motor with propellant, electric igniter and a nozzle and fin assembly. The basic components are shown below.

The 60 millimeter HEAT warhead is of the classic type with a steel body, ogive shaped stand-off shield, copper liner and Pentolite main charge. The warhead body base is fastened to a male threaded union.

The M4O1 fuze is a simple, non-delay, inertia actuated type. It consists of a detonator, percussion primer, spring restrained inertia firing pin and two safeties. One is a manual safety pin removed at loading, another is a bore-riding safety pin released by the set-back during firing and held in place by the launcher tube wall until the projectile leaves the muzzle. The fuze assembly is housed in the front portion of the rocket motor. The M401 fuze is extremely sensitive. A blow on the warhead nose equivalent to a 130mm (5 inch) drop on a hard surface will fire the warhead.

The M6 rocket motor is a seamless, heavy wall, steel tubing 31.7mm ($1^1/_4$ inch) outside diameter and 25.7 mm (1 inch) inside diameter with a wall thickness of 3.0 mm ($^1/_8$ inch). The front of the motor is a steel part brazed to the tube. It serves as the base for the detonator-striker assembly. The motor front end is threaded onto the warhead union piece. The motor nozzle is part of the fin assembly.

The initial M-6 series Bazooka rocket motor contained a single cylindrical propellant grain 22 millimeters in diameter with a 6 millimeter hole through the center. This grain configuration gave a slow burning rate, particularly at low temperatures. The grain continued to burn even after exit from the launcher with the gases burning the shooter's face. Subsequently the propellant was modified. The new charge consisted of five individual grains of $9\ ^1/_2$ millimeter diameter with a 1.6 millimeter hole in center. The chemical composition was a modification of a conventional double-base powder and was called "Blastless Bazooka Propellant" (BBP) type M-7.

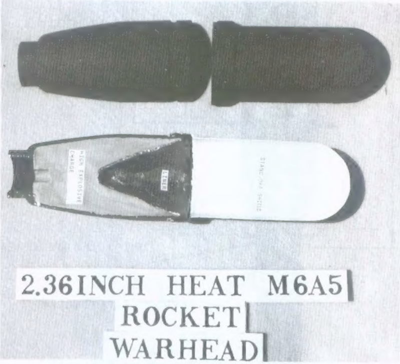
The M-7 propellant composition is:

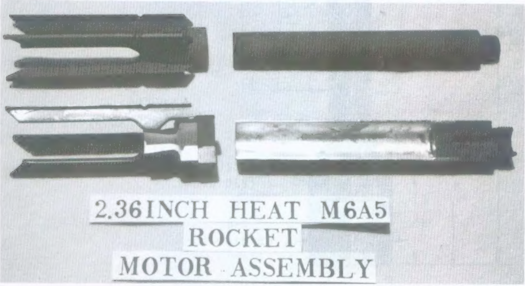
Material	% by weight
Nitrocellulose	54.6
Nitroglycerine	35.5
Potassium chlorate	7.8
Carbon black	1.2
Ethyl centralite	0.9

While the M-6 series rocket motors were expected to operate at 500 Atmospheres (about 7500 psi), the later rocket motors were operating at 700 Atmospheres (10000 psi) and even 900 Atmospheres (13000 psi). For comparison, modern shotguns are proof fired at 900 Atmospheres and U. S. commercial shotshells operate at 700 Atmospheres.

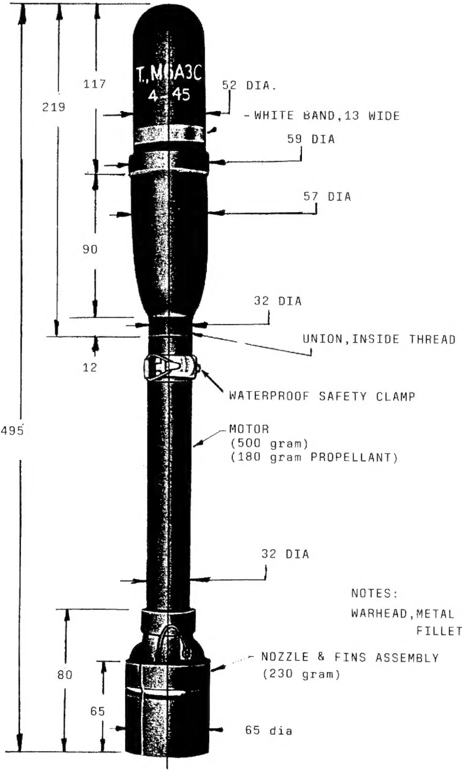
The electric igniter is held by a plastic nozzle cup inside the nozzle-and-fin assembly. One of the igniter wires is soldered to a fin (ground) while the other (hot) is connected at loading to the launcher electric current generator.

The nozzle-and fin assembly consists of aluminum nozzle, six fins and a circular shroud, all welded together. The assembly, with the igniter seated in, is screwed onto the rear end of the rocket motor.





2.36 INCH HEAT ROCKET M6A3C



NOTES:

WARHEAD, METAL PARTS 450 g
FILLET 450 g

ALL DIMENSIONS IN MILLIMETERS